THE FAUNA OF THE PORTRANE LIMESTONE, IV
POLYZOA

BY

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THE FAUNA OF THE PORTRANE LIMESTONE, IV: POLYZOA

By J. R. P. PHILLIPS ROSS*

CONTENTS

SYNOPSIS

In the Portrane Limestone the Orders Trepostomata, Cryptostomata and Cyclostomata are represented by 19 genera and 26 species which comprise a very distinct fauna dominated by delicate cryptostomes. The trepostome *Anaphragma* is represented by a new species, *A. portranense*. *Mitoclemella?* sp. A is a very significant cryptostome occurrence because the genus

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Mitoclemella has only been previously recorded from the Prosser Formation, Minnesota, and the C_2 horizon of Estonia. An unusual polyzoan with a cup-like form is another early representative of the cyclostome family Diastoporidae and appears closely similar to the Cretaceous genus *Discosparsa*.

I. INTRODUCTION

This investigation of the Polyzoa[1] is part of a study by several palaeontologists examining the fauna of the Portrane Limestone. Wright (1963), who collected and etched large blocks of the Portrane Limestone, has discussed and outlined the stratigraphic sequence and the proposed description of the Upper Ordovician fauna.

The polyzoans from the Portrane Limestone are variously preserved: (1) some colonies are partly silicified; (2) others have recrystallized calcareous skeletal structures; and (3) yet others are well preserved calcareous colonies. The very careful etching and processing of the etched material by Dr. Wright resulted in the recovery of many minute and delicate fragments of cryptostome and cyclostome polyzoans. These fragments present much data on the morphology of some of the species that otherwise would be impossible to assemble from thin sections because the colonies were extensively fragmented during the deposition of the Portrane Limestone. The etched trepostome colonies generally are considerably larger in diameter than the cryptostomes and their surfaces are commonly completely silicified so that external surface features of the zoaria can be readily observed. However, the internal structures of these trepostomes are very incompletely preserved and the material is not suitable for thin sectioning. The thin sections of the cryptostomes and trepostomes were made from random cuts through blocks of polyzoan-bearing limestone. However, very extensive thin sectioning has not revealed all the minute cryptostomes and cyclostomes that are preserved in the etched material.

Identifying the Portrane material has involved a number of difficulties, largely due to two factors. First, the small, etched fragments commonly do not permit complete description of a species because information about the general aspects of a colony and its internal structures are not determinable. Secondly, the early literature which described many of the forms similar to the Portrane fauna commonly does not present a detailed discussion of the species and genera and only a limited amount of data can be obtained from the published illustrations.

The Portrane polyzoans are represented by at least 19 genera and 26 species. Many of the genera such as *Enallopora*, *Mitoclemella* and *Anaphragma* are distinctive forms and this profusion of different forms at one locality is similar to the abundant faunas found in the Estonian late Ordovician and in parts of the Cincinnatian of the United States. Portrane is a locality intermediate between these two regions and it contains many polyzoan genera common to the North American and Baltic areas. At the species level, the Portrane assemblage has little similarity with that of either the United States or Estonia.

The species offer no refined data about the age of the Portrane Limestone at the present time because of the many gaps in our knowledge of Ordovician polyzoan

[1] Polyzoa is used in the text in conformity with the usage of the Museum.

distributions. *Anaphragma portranense* has little similarity with the few species so far attributed to this genus from either the Cincinnatian, Wilmington, Illinois, or the F_1 horizon in Estonia. *Calopora* sp. A belongs to a group which includes the type species of *Calopora* and which ranges from Trentonian to Niagaran in the United States. *Amplexopora* sp. appears to belong to the group of typical species of *Amplexopora*, the type species occurring in the " Cincinnati Group ", Ohio and Kentucky. *Enallopora* sp. A has similarities with species from the Trentonian of New York State, Cincinnatian at Wilmington, Illinois, and the D_1 to F_{1c} horizons of Estonia. *Mitoclemella?* sp. A is a distinct form showing similarity with the type species of *Mitoclemella* from the " Trenton ", Minnesota, U.S.A., whereas the species of *Penniretepora* show no close similarities. *Pseudohornera?* sp. A has some similarity with a species from the C_3 horizon of Estonia. A very slender species of *Ptilodictya*, *Ptilodictya* sp. A, has similarities with *P. ensiformis* which ranges from the Cincinnatian to Niagaran, Anticosti Island. A more robust species, *Ptilodictya* sp. B, belongs to a group which includes the type species, *P. lanceolata*, and *P. canadensis*.

Only broad correlation between the Portrane and Estonian faunas based on the genera is at present possible because much additional data on Ordovician polyzoan faunas in many regions has yet to be compiled. In the Estonian succession Männil (1959, 1962) has documented the occurrence of many of the genera which are also found in the Portrane fauna. Männil (1959 : 38) recorded *Ptilodictya* as extending down to the F_{1a} horizon, but (1962) modified this range so that the genus is now considered to extend down into the D horizon ; it extends upwards into the Silurian. Männil (1959, 1962) indicated that *Glauconomella* extended from F_{1a} into the Silurian. Depending on the redefinition of *Glauconomella*, some of the Portrane forms assigned to *Penniretepora* in the present study may belong to *Glauconomella*. *Stictopora* is known from the C_{1b} horizon and extends upwards ; *Pachydictya*, *Nematopora*, and *Calopora* are first recorded in the C_{1a} horizon ; *Anaphragma* extends from the D_2 to F_{1b} horizons, and *Dianulites* from the B_2 into at least the F_2 horizon ; *Enallopora* and *Pseudohornera* occur in C_{1b}, and *Mitoclemella* was recorded by Bassler (1911) from the C_2 horizon.

The Portrane polyzoan fauna, based on comparisons with the present incomplete faunal data from other regions, could be as old as faunas from the D horizon of the Estonian succession and as young as those from the F_2 horizon in the Estonian succession.

II. SYSTEMATIC DESCRIPTIONS

Order TREPOSTOMATA Ulrich

Genus *ANAPHRAGMA* Ulrich & Bassler

Anaphragma portranense sp. nov.

(Pl. 1, figs. 1, 2, 4, 6 ; ? Pl. 6, figs. 4, 6)

Diagnosis. *Anaphragma* with slender branches having large zooecial openings, numerous small acanthopores which penetrate the junctions of zooecial walls and mesopore walls, and numerous mesopores.

MATERIAL. Holotype PD.4390, paratype PD.4391. Questionably assigned to the species, PD.4425, PD.4432.

DESCRIPTION. Slender zoarial branches are circular in transverse section. Well defined axial regions shows slender irregularly crenulate zooecial walls which thicken as they pass into the peripheral region. In longitudinal section zooecial walls in the peripheral region have steeply inclined laminae in their inner parts; these laminae curve sharply and intertongue with laminae of adjacent zooecial walls in an irregular zig-zag band so as to form a dark amalgamate-integrate outer wall. In tangential section the inner parts of the zooecial walls are well defined as distinct concentric bands. Concentric bands of adjacent zooecial walls are separated by a dark, amalgamate, and partly granulose outer wall. Acanthopores of variable diameter penetrate this amalgamate outer region of the zooecial walls and slightly inflect the outer part of the concentric inner walls. Central part of acanthopores is filled with calcite and surrounded by concentric laminae of acanthopore wall. Acanthopores and mesopores are generally located at the junctions of zooecial walls. Walls enclosing mesopores are similar in structure to zooecial walls and may be inflected by acanthopores. Mesopores are all shapes and sizes with no arrangement of the major axis of the opening in the direction of growth.

MEASUREMENTS OF HOLOTYPE IN MM.

Diameter of zoarial branch	3·32
No. of zooecial openings per 2 mm.	$3\frac{1}{2}$ to 4
Diameter of zooecial opening	min. 0·33 × 0·28 max. 0·44 × 0·42
No. of mesopores per zooecium	1 to 5
Diameter of mesopores	longitudinal axis 0·04 to 0·21 lateral axis 0·03 to 0·24
No. of acanthopores per zooecium	3 to 7
Diameter of acanthopores	0·015 to 0·027
Thickness of zooecial wall	0·07 to 0·14
Thickness of mesopore wall	0·04 to 0·08
Diameter of axial region	2·0
Axial ratio	0·6

REMARKS. The distinctive genus *Anaphragma* has so far been reported from only a few widely separated areas in the late Ordovician: "Maquoketa Group, Wilmington, Illinois" (Ulrich & Bassler 1904), and the "upper part of the Lyckholm limestone (F_1) at Kertel, and at Hohenholm on the island of Dago" (Bassler 1911 : 299).

The Portrane species has very little similarity to the type species, *A. mirabile* Ulrich & Bassler. *A. portranense* is similar to *A. mirabile* (as figured by Boardman 1960, pl. 3, fig. 3*c*) in the arrangement of the zooecial openings, mesopores and acanthopores. However, *A. portranense* has very slender cylindrical stems, larger zooecial openings and a slightly greater number of mesopores in comparison with *A. mirabile*. Both species have a wide range of sizes of mesopores, small acantho-

pores, and thick zooecial walls. In *A. portranense* the peripheral region is considerably narrower and the zooecial tubes bend more sharply than in *A. mirabile*, and, in addition, some of the smaller acanthopores are not restricted to the junctions of the zooecial walls as they are in *A. mirabile*.

The etched specimens PD.4425 (Pl. 6, fig. 5) and PD.4432 (Pl. 6, fig. 14) have general external features which suggest *Anaphragma*, but they are questionably assigned to the genus because their internal structures are not known.

Genus *CALOPORA* Hall

Calopora sp. A

(Pl. 3, figs. 1–4, 6, 8; Pl. 6, fig. 1)

Material. Includes PD.4394–96, 4422.

Description. A species of *Calopora* with round zooecial openings surrounded, but not completely isolated, by mesopores. Mesopores have closely spaced diaphragms. Less robust branches (Pl. 3, figs. 2, 3) have more slender zooecial walls and very few diaphragms in the peripheral region. Robust specimens (Pl. 3, figs. 6, 8) have numerous diaphragms in the peripheral region. Surface of colony has very distinct mounds (see left side of specimen Pl. 6, fig. 1) in which zooecial openings and mesopores have the usual average diameter.

Remarks. This Portrane species can be compared with a number of typical species of *Calopora*. *C. elegantula* from the Rochester Formation, New York, has numerous angular mesopores which form a circlet around the circular zooecial openings. Diaphragms are widely spaced in the zooecial tubes and more closely spaced in the mesopores. In comparison with the Portrane species, *C. elegantula* has more numerous mesopores and diaphragms and the diaphragms are curved and sometimes incomplete. *C. incontroversa* (Ulrich) from "lower third of the Trenton shales at Minneapolis, St. Paul, and Preston, Minn." (Ulrich 1893 : 279) has more zooecial openings per 2 mm. and probably fewer mesopores per zooecium than the Portrane species. Both species have closely spaced diaphragms in the zooecial tubes in the peripheral and subperipheral regions separated by an intermediate region between them in which diaphragms are sparse or lacking. *C. dumalis* (Ulrich "common in *Phylloporina* bed of the Black River (Decorah) shales, and in the *Clitambonites* bed of the lowest Trenton at St. Paul and Cannon Falls, Minnesota," has similarities to *Calopora* sp. A in its slender cylindrical branches (1·5 to 2·0 mm. diameter) and in the shape and abundance and arrangement of mesopores. The two species are also alike in the spacing of the diaphragms, which are not crowded in the outer peripheral region. *C. dumalis* has a considerably greater number of zooecia per 2 mm. and zooecial tubes are oblique to the zoarial surface in young stages of growth. The two species are similar in the abundance and distinctness of mesopores.

Longitudinal sections of young growth stages of *Calopora* sp. A (Pl. 3, figs. 2, 3) have a sparsity of diaphragms in the zooecial tubes and closely spaced diaphragms in the mesopores as in *C. tolli* (Bassler 1911 : 333–334). However, the general

dimensions of the zoarial stem of *C. tolli* are considerably greater (6 to 8 mm.) in comparison to the Portrane species. Both species have a similar number of zooecial openings per 2 mm. and thin zooecial walls. *C. tolli* is reported " Rare in the Jewe limestone (D_1), Baron Toll's estate, Kuckers shale (C_2), Reval, and in the Kegel limestone (D_2), Kegel, Esthonia " (Bassler 1911 : 334). *C. gracilens* (Bassler) (1928 : 154–155) from the " Vaureal (4, 5), Battery and West Points," Anticosti Island, is similar to the Portrane species in the slender zoarial stems (2 mm. diameter) and the number of zooecial openings per 2 mm. (4 to 5 per 2 mm.). The Portrane species has distinct, elevated broad areas on its zoarial surface which are lacking in *C. gracilens*. In both species the mesopores appear crowded with diaphragms, but in the zooecial tubes the Portrane species has a generous scattering of diaphragms which are very sparse in *C. gracilens*. *C. subnodosa* (Ulrich) (1890 : 417, pl. 33, figs. 5–5*c*) from the " upper beds of the Cincinnati group, Blanchester, O., and numerous other localities " has considerably thicker zoarial stems, more abundant zooecial openings per 2 mm. and a wider peripheral region than the Portrane species. Though the two species are quite distinct, they are similar in the comparable abundance of mesopores around the zooecial openings, the arrangement of diaphragms in the mesopores, the thin zooecial walls, and the arrangement of diaphragms in the subperipheral region of the zooecial tube. However, diaphragms may be absent in the peripheral region of *C. subnodosa* and are present in the peripheral region of the Portrane species. *C. bassleri* (Hennig 1908 : 52–54, pl. 3, fig. 17; pl. 7, figs. 2, 10, text-figs. 62, 63) from " Lansa på, Fårö, Norderstrand vid Visby, Petesvik i Hablingo "

Measurements in mm.

	PD.4394	PD.4395	PD.4422
Diameter of zoarial branch	1·8 incomplete	2·3	3·1 to 3·6
No. of zooecial openings per 2 mm. longitudinally	4 to $4\frac{1}{2}$	$3\frac{1}{2}$ to 4	3 to 4
Diameter of zooecial openings	0·24×0·16 0·29×0·26	0·22×0·39	0·25×0·19 0·38×0·31
No. of mesopores per zooecium	6 to 7	Not determined	2 to 6
Diameter of mesopores	0·13×0·05 0·21×0·11	0·05 to 0·30 longitudinally	0·28×0·25 0·10×0·10
Thickness of zooecial wall	0·01 to 0·03	0·01 to 0·015	0·03 to 0·04
Thickness of mesopore wall	0·01 to 0·02	0·01 to 0·015	0·03 to 0·04

has certain similarities to the young growth stages of the Portrane species (Pl. 3, fig. 2) which closely resembles the longitudinal section illustrated by Hennig (1908, text-fig. 62). Hennig's specimen has more sparsely spaced diaphragms in the peripheral region and these are lacking in the Portrane specimen. *C. bassleri* has 6 zooecial openings per 2 mm. which is greater than that in the Portrane species and, in addition, *C. bassleri* appears to have slightly more mesopores around the zooecia openings.

Calopora sp. B

(Pl. 6, fig. 2)

MATERIAL. PD.4423.

DESCRIPTION. This form, represented by a single etched specimen, is characterized by slender branches with small zooecial openings that are almost isolated by a circlet of polygonal or occasionally round mesopores (Pl. 6, fig. 2). Maculae consisting of mesopores occur at intervals across the zoarial surface. The maculae, about 0·37 mm. × 0·30 mm., consist of flat areas of mesopores surrounded by large zooecial openings.

REMARKS. Without internal features it is difficult to make comparison with other species, but in the smaller size of the zooecial openings, greater abundance of mesopores, and the presence of maculae, this species differs from *Calopora* sp. A.

MEASUREMENTS in mm.

Diameter of zoarial branch	2·4 to 3·9
No. of zooecial openings per 2 mm. longitudinally	$6\frac{1}{2}$ to 7
Diameter of zooecial opening	0·22×0·27
	0·20×0·25
No. of mesopores per zooecium . . .	8 to 10
Diameter of mesopores	0·02×0·02 to 0·10×0·11
Thickness of zooecial wall	0·02 to 0·04
Diameter of mesopores	0·02 to 0·10

Genus ***DIANULITES*** Eichwald

Dianulites? sp.

(Pl. 2, figs. 1–8)

MATERIAL. Five thin sectioned fragments, PD.4385–89.

DESCRIPTION. Thin sections reveal colonies with very distinctive tangential sections. In shallow tangential sections (Pl. 2, figs. 1, 8) the subpolygonal zooecial openings are surrounded by small mesopores and wide zooecial walls; deeper tangential sections display circular zooecial tubes and larger polygonal mesopores in concentric bands around the zooecia. The mesopore and zooecial walls are similar in structure and width and are finely granulate and amalgamate. Magnifications ×200 show that the inner part of a wall is lined with a narrow concentric band of granular calcite.

An oblique longitudinal section shows abundant diaphragms in the mesopores, and two or three diaphragms are visible in two of the zooecial tubes. The zooecial walls at magnifications ×200 have a distinct inner wall of longitudinal granular calcite which is indistinct at lower magnifications. Adjacent zooecial walls appear amalgamate and display a dense granular structure with a vague, slightly curved alignment of the calcite grains.

Remarks. This form, so distinct in thin sections, appears very different from previously described species. Unfortunately, not all the features of a colony of this species are known because it has only been observed in a relatively small number of thin sections which do not display all features of the zooecial tubes.

It is difficult to place this species in any known genus because its distinctive features lack similarity to those of known genera. Initially a tangential section (Pl. 2, figs. 1, 8) with mesopores and round zooecial openings would suggest *Calopora*, but the granular wall structure is completely different from the laminate wall structure of *Calpora*. This difference is striking when, as in the Portrane Limestone material, the two different wall structures of *Dianulites?* and *Calopora* are viewed in the same thin section.

The species is questionably assigned to *Dianulites* because it has general similarities to some forms placed in the genus, for instance those described by Bassler (1911) from Estonia—however, none is closely similar to the Portrane species. The Estonian species have angular zooecial openings and thinner zooecial walls. Because little detailed morphology is known about *Dianulites*, redescription of the original type material of the genus is necessary in order to determine the taxonomic position of many European and North American species referred to it.

Measurements in mm.

	PD.4385	PD.4386
Diameter of zooecial opening	min. 0·26×0·16 max. 0·54×0·42	min. 0·22×0·27 min. 0·29×0·33
No. of zooecial openings per 2 mm.	approx. 3 to $3\frac{1}{2}$	4 to 5
No. of mesopores around a zooecium	11 to 13	1 to 5
Dimensions of mesopores	0·04 square 0·03×0·20 rectangle 0·10×0·42 rectangle 0·14 side of polygon	0·02×0·13 0·17×0·11 rectangle
Thickness of zooecial wall	0·05 to 0·08	0·10 to 0·13
Thickness of mesopore wall	0·02 to 0·05	0·04 to 0·08

The Portrane *Dianulites?* sp. is somewhat similar to the type species of *Phragmopora, P. multiporatum* Bassler (1911), from the Kuckers Limestone (C_2), near Jewe Estonia (Pl. 8, figs. 4, 6). Tangential sections of both species have round zooecial openings enclosed by regular polygonal mesopores which are concentrically arranged around the zooecial openings ; in addition, the wall structure appears similar. In longitudinal section, however, they are very different—*P. multiporatum* has hemiphragms in the zooecial tubes but they are lacking in *Dianulites?* sp.

Genus ***AMPLEXOPORA*** Ulrich

Amplexopora sp.

(Pl. 1, fig. 5 ; Pl. 4, figs. 8, 9 ; ?Pl. 7, fig. 12)

Material. PD.4393, 4406–7. Questionably assigned to the genus, PD.4444.

Description. Three fragments have delicate, possibly incrusting, laminate colonies with slender zooecial walls, numerous small but distinct acanthopores which slightly inflect the zooecial walls, and zooecial tubes and mesopores which have diaphragms. An occasional acanthopore appears on the inside of the mesopore wall. Acanthopores have distinctly thick walls with steeply inclined laminae. Zooecial walls are integrate but lack the distinct dark line which bounds the outer part of the zooecial wall in the genus *Batostoma*.

Remarks. The few fragments of this species do not permit a detailed comparison with other species. However, they appear to belong to the species complex that includes the type species of *Amplexopora*. Tangential sections have a general resemblance to *A. septosa* (Boardman 1960, pl. 6, fig. 3*c*), in that both species have slender zooecial walls and inflecting acanthopores which are quite distinct. *A. septosa* is most probably a much more robust species. Its primary types are from the " Mount Hope shale member of the Fairview formation, Maysville group, of the upper Ordovician at Covington, Ky." (Boardman 1960 : 20). In specimens of *A. septosa* in which the zooecial walls are inflected there are about 4 to 5 acanthopores per zooecium and the Portrane species has 5 to 7. Zooecial openings of the two species are approximately of the same diameter. Another species belonging to the *A. cingulata-A. septosa* group is *A. affinis*. This species, described by Ulrich (1890 : 450–451, pl. 36, figs. 2–2*a*), is similar to the Portrane species in the distinctive acanthopores and thin zooecial walls.

An etched specimen (PD.4444—Pl. 7, fig. 12) with closely packed polygonal zooecial openings encircling a slender cylindrical stem is provisionally assigned to *Amplexopora*.

Measurements of PD.4393 in mm.

Diameter of zooecial opening	0·24×0·16 to 0·21×0·16
Diameter of acanthopore	0·02 to 0·04
Diameter of mesopore	0·04×0·04 to 0·04×0·11
Acanthopores per zooecium	5 to 7
Thickness of zooecial wall	0·01

Genus ***BYTHOPORA*** Miller & Dyer

1878 *Bythopora* Miller & Dyer : 6.

Type species. *Bythopora dendrina* (James). Holotype, M.C.Z.2144 " middle part of the Cincinnati Group, at Cincinnati " (Miller & Dyer 1878 : 6).

Diagnosis. Very slender cylindrical branches with zooecial openings steeply inclined to periphery. Oval zooecial openings enclosed by amalgamate zooecial walls which are penetrated by three, four or five small acanthopores. Very shallow mesopores occurring in peripheral part of zooecial walls. In longitudinal sections zooecial walls composed of steeply inclined laminae curving convexly distally in median region between adjacent zooecial walls.

Bythopora? sp.

(Pl. 1, fig. 3)

Material. One thin section, PD.4392.

Remarks. An oblique longitudinal section shows limited characters of a tangential and longitudinal orientation through an exceptionally slender cylindrical stem provisionally assigned to *Bythopora*. In tangential view the circular zooecial openings are surrounded by small acanthopores (commonly 10 acanthopores per zooecium). The zooecial openings appear to rise obliquely to the periphery.

Measurements in mm.

Diameter of zoarial stem	1
Diameter of zooecial openings	0·13 to 0·16
Diameter of acanthopore	0·02 to 0·03

Order CRYPTOSTOMATA Vine

Genus ***ENALLOPORA*** d'Orbigny

1849 *Enallopora* d'Orbigny : 502.
1889 *Protocrisina* Ulrich : 317.
1890 *Protocrisina* Ulrich ; Ulrich : 369.

Type species : *Gorgonia perantiqua* Hall 1847 : 76.

Diagnosis. Colony with bifurcating branches. Celluliferous obverse surface with four rows of zooecia across a branch. Zooecial openings projecting distally above obverse surface. Two rows of zooecia on either side of median lamina. Finely granular, slightly curved reverse surface.

Enallopora perantiqua (Hall)

1847 *Gorgonia perantiqua* Hall : 76, pl. 26, figs. 5*a*, 5*b*.
1849 *Enallopora perantiqua* (Hall) d'Orbigny : 502.

Holotype. AMNH 665/1, figured by Hall 1847, pl. 26, figs. 5*a*, *b*, from " Trenton, Middleville, N.Y."

DESCRIPTION. Bifurcating colony, enclosed in black fissile shale, has four rows of circular zooecial openings on obverse surface which extends around 2/3 of the perimeter of the zoarial stem. The lateral rows of zooecia are directed outwards beyond the lateral margins of the zoarial stem ; diameter of lateral zooecial openings 0·11 to 0·14 mm. Two rows of median zooecia are separated by a median lamina ; zooecial openings are directed distally. Zooecial tubes extend as long cylindrical tubes originating near the reverse surface.

MEASUREMENTS in mm.

	AMNH 665/1
Width of zoarial branch	0·55 to 0·65
Angle of bifurcation of branches	12 to 35 degrees
Distance between bifurcation (varies in different parts of colony)	2·5 to 2·9 4·9 to 5·1
No. of zooecia per 2 mm. longitudinally in lateral ranges	$4\frac{1}{2}$
Thickness of zoarial branch	0·35
Diameter of zooecial opening	0·11 to 0·14

Enallopora sp. A

(Pl. 6, figs. 6, 7)

MATERIAL. Seven fragments, PD.4426–27, 4449–51, 4454–55.

DESCRIPTION. Very slender cylindrical bifurcating branches have no zooecia on the lower reverse surface which covers about 1/3 of the perimeter of branch. Four longitudinal rows of zooecia extend along the remaining 2/3 of the perimeter. Distally oblique zooecial openings at the zoarial surface extend in almost spiral arrangement diagonally and distally along the stem.

MEASUREMENTS in mm.

	PD.4426	PD.4427
Diameter of zoarial stem	0·5 to 0·6	0·5 to 0·6
Diameter of zooecial opening	0·20×0·15	0·20×0·15 0·17×0·12
No. of zooecia per 2 mm.	3 to $3\frac{1}{2}$	3
Distance between successive zooecial openings	0·4 to 0·6	0·3 to 0·6

REMARKS. The Portrane species is externally similar to several species, including *Enallopora perantiqua* (Hall), *E. exigua* (Ulrich), *E. alliku* Männil, and *E. moe* Männil. The type material of *E. perantiqua* is very difficult to study owing to its preservation in a black fissile shale which crumbles readily, so that only part of the holotype (Hall 1847, pl. 26, figs. 5*a*, *b*) is now preserved. This species has a similar silhouette of lateral projecting zooecial openings, similar branch diameter, slightly more zooecial openings per 2 mm., and slightly smaller zooecial openings (0·11 to 0·14 mm.) in comparison with the Portrane species. *E. exigua* was noted by Ulrich (1890 : 405)

to be " rare at Wilmington, Ill., where it is associated with typical Cincinnati group fossils. It is more common and in a better state of preservation in Trenton group strata at Montreal, Canada, and Trenton Falls, N.Y."; compared with the Portrane species, this species has about the same branch diameter, more zooecial openings per 2 mm. (5 to $5\frac{1}{2}$ in 2 mm.) and smaller zooecial openings (0·09 mm.). *E. alliku* Männil from the Estonian D_1 to D_3, E?, has a slightly more slender zoarial stem, zooecial openings of about the same diameter, and a greater number of zooecial openings (4 to 5 per 2 mm.), in comparison with *Enallopora* sp. A. Both species have oblique zooecial openings ; those in the Portrane species appear to be the more oblique. The silhouette of both species from the reverse surface is similar. Compared with *Enallopora* sp. A, *E. moe* from the Estonian F_{1a} to F_{1c} has a considerably thicker zoarial stem and zooecial openings of about the same size, which are, however, more numerous per 2 mm. (4 to $4\frac{1}{2}$) and considerably more oblique.

Genus ***MITOCLEMELLA*** Bassler

1952 *Mitoclemella* Bassler : 381.

Diagnosis. Zoarium ramose, very small (0·5 to 0·6 mm. diameter of branch). Tubular zooecia projecting strongly upward and outward and not constricted at the zooecial openings. Zoarial surface with faint transverse striae or wrinkles. (After Ulrich 1890 : 177).

Type species. *Mitoclema? mundulum* Ulrich (1890 : 177, text-fig. 4) ; " Top of Trenton Shales, at Cannon Falls, Minnesota."

Remarks. When Ulrich (1890) described *Mitoclema? mundulum*, he was dubious that his species might not be a species of *Diploclema*. However, as he did not know the internal features of his species, he questionably assigned it to *Mitoclema*. Bassler (1952 : 381) erected *Mitoclemella* for a genus " Like *Mitoclema*, but apertures project upward in rapidly ascending spirals ". He did not re-describe the type species, so that only the external structures as given by Ulrich (1890) are known. The Portrane species, which provisionally appears to belong to this genus, is a collection of etched specimens and has not been determined in thin section.

***Mitoclemella*? sp. A**

(Pl. 5, fig. 3 ; Pl. 6, figs. 11, 12 ; Pl. 7, fig. 5)

Material. Nine etched specimens, PD.4419–21, 4437, 4446, 4452, 4458, 4464, and 4601.

Description. Branches large for the genus, cylindrical, with zooecial openings covering the entire surface. Zooecial tubes project obliquely upward and outward and show no constriction of the zooecial openings. Small pits, commonly single or paired, penetrate the zoarial surface in the longitudinal interspaces between succeeding zooecia. The zooecial openings are diagonally aligned along the zoarial stem, and on a weathered surface they are very irregular in outline.

Measurements of PD.4420 in mm.

Diameter of zoarial stem	2·0
Diameter of zooecial opening	0·10 to 0·18
Diameter of pits	0·05

Remarks. The Portrane species has considerably larger zoarial stems (2·0 mm.) than those of *M. mundulum* (Ulrich) (0·5 to 0·6 mm.). The diameter of the zooecial openings of the two species is, however, very similar. There is no reference in Ulrich's description to pits similar to those found in the Portrane species and in the present discussion these structures are regarded as only of specific criterion. Ulrich (1890 : 177) indicated that the zoarial surface between zooecia had faint transverse striae or wrinkles, but such features have not been observed in the Portrane material.

Genus ***PENNIRETEPORA*** d'Orbigny

1849 *Penniretepora* d'Orbigny : 501 (non d'Orbigny 1850 : 45).
1884 *Pinnatopora* Vine : 191.
1884 *Pinnatopora* Vine ; Shrubsole & Vine : 330.
Glauconome authors (non Goldfuss 1826).

Diagnosis. " Deux rangées de cellules d'un seul côté d'un ensemble penniforms, composé d'une tige et de rameaux libres lateraux, non anastomosés." (d'Orbigny 1849 : 501).

Type species. *Retepora pluma* Phillips (1836 : 199, pl. 1, figs. 13–15).

Remarks. *Penniretepora*, which ranges from the Ordovician to the Permian, includes many species that have had a complex nomenclatorial history, particularly those from the Ordovician and Silurian of Great Britain and western Europe which have been assigned to the genus *Glauconome* Goldfuss.

Penniretepora is used in the present study in preference to *Glauconome* and a brief digression on the nomenclatural history of *Glauconome* outlines the basis for this. The name *Glauconome*, originally used to define a pelecypod by Gray (1828), was inadvertently used by Goldfuss (1831) for a polyzoan. Thus in accordance with the International Rules of Zoological Nomenclature, *Glauconome* Goldfuss is a junior homonym and is to be rejected.

The nomenclature is further complicated because the generally accepted type species of *Glauconome* Goldfuss, *G. disticha* Goldfuss, was not one of the species in the original group of forms described by Goldfuss. Goldfuss's specimens of *G. disticha* were five in number—four have been re-assigned to the Tertiary to Recent genus, *Vincularia*, and the fifth is from the Silurian Wenlock Limestone, Dudley, England. It was this fifth specimen upon which the concept of *Glauconome* Goldfuss was developed, although it was embedded in rock so that many of the characters were not defined by Goldfuss.

Lonsdale (1839 : 677) re-defined *Glauconome* Goldfuss but based his re-description of *G. disticha* upon additional material from the Wenlock Limestone of Dudley, and not on Goldfuss' type material. However, it is hard to determine whether Lonsdale's

specimens were congeneric with Goldfuss's, a matter which Phillips (1841) and M'Coy (1854) apparently realized. *G. disticha* (Lonsdale 1839 : 677) was described as having " four rows of long quadrangular cells at one side." However, in most studies the forms assigned to Lower Paleozoic representatives of *Glauconome*, including Goldfuss's imperfectly known material, are stated to have two rows of zooecia along the obverse surface. Lonsdale's figures (1839, pl. 15, figs. 12, 12*a*, 12*b*) appear to represent forms which are more precisely described by M'Coy (1854) as having " two rows of cells on one face which is usually carinated between them ; in some species a row of small cells on the keel." Some of the Portrane specimens, e.g., PD.4424, clearly display the features noted by M'Coy. Phillips (1841 : 21) likewise defined " *Glauconome* " as having two lines of zooecial openings along the branch, but noted that " there are signs of lateral rows in *G. disticha.*" He was apparently referring to Lonsdale's material of *G. disticha* because he stated, " The single species of *Glauconome* of Goldfuss, to which this generic name had been preserved by Lonsdale." Some of this complicated history of " *Glauconome* " was discussed by Etheridge (1877).

Bassler (1952 : 384) erected the new name *Glauconomella* for " *Glauconome* authors, non Goldfuss, 1829, Petr. Germ., p. 100, pl. 36, figs. 5–8, based on unrecognizable *Vincularias* from the Tertiary of Germany ". He listed *Glauconome disticha* Goldfuss (1831 : 217, pl. 64, fig. 15*b*) as the type species of *Glauconomella*. *Glauconomella* may be a valid name as it is a new name for *Glauconome* (pars) Goldfuss, but, at present, because no revision has been undertaken of Goldfuss's type material, the detailed characters of *Glauconomella* and *G. disticha* (Goldfuss) are not known. Because d'Orbigny's description of the genus *Penniretepora* appears more precisely defined and because this genus appears to have characters closely similar to those attributed to *Glauconome* = *Glauconomella*, particularly with respect to the two rows of zooecial openings on the obverse surface, *Penniretepora* is used in the present study in preference to *Glauconomella*.

Penniretepora sp. A

(Pl. 6, fig. 3; Pl. 8, fig. 5)

MATERIAL. One etched specimen, PD.4424.

DESCRIPTION. Pinnate colony with the main stem slightly thicker than the lateral branches which are slanted obliquely to the main stem. Two rows of zooecia on sloping surfaces are separated by a noded median ridge. Lateral branches alternate on either side of the main stem and have similar structure to it. Reverse surface with faint longitudinal striae and knobbles. Zooecial openings consistently occur on the main stem at the junctions with the lateral stems.

MEASUREMENTS of PD.4424 in mm.

Diameter of main stem	0·35
Diameter of lateral branches	0·22
No. of zooecia per 2 mm. on main stem	8 to 8½

No. of zooecia per 2 mm. on lateral stem	8
Diameter of zooecial opening on main stem	0·07×0·05 0·10×0·07
No. of zooecia on main stem between successive lateral branches	2
Distance between adjacent lateral branches	0·45
Distance between adjacent lateral branches on opposite sides of main stem	0·22
Nodes per 2 mm. on median ridge	8
Angle of divergence between side branches and main stem	60 to 70 degrees
Distance between centres of successive zooecial openings	0·20 to 0·25

Remarks. The few Lower Paleozoic species of *Penniretepora* and *Glauconome* from England, Estonia, U.S.S.R., Scandinavia, and Australia, which are adequately described, appear to have no close similarity to the Portrane species. The Silurian species *P. lobata* Crockford (1941 : 110–111) from the Yass district, N.S.W., Australia, has a narrow main stem but the side branches and zooecial openings are considerably more widely spaced. Two species, *Glauconome plumula* Wiman and *G. strigosa* (Billings), discussed by Bassler (1911 : 159–162) from the Ordovician of Estonia, have no close similarity to the Portrane species ; *G. plumula*, for instance, apparently has four rows of zooecia on the obverse surface.

Penniretepora sp. B

Material. One etched specimen, PD.4447.

Description. Pinnate colony with two rows of zooecial openings on a slightly curved zoarial obverse surface. Reverse surface striated and striae also present between the zoarial branches and the zooecial openings. The faint median ridge has three rows of striae which are very distinct. Zooecial openings on the main stem are not in regular longitudinal lines because those which occur at junctions of main stems and lateral branches are displaced on to the lateral branches.

Measurements of PD.4447 in mm.

Diameter of main zoarial stem	0·5
Diameter of lateral zoarial stems	0·2 to 0·3
No. of zooecia per 2 mm. longitudinally on main stem	7
No. of zooecia on main stem between lateral branches	1
Diameter of zooecial openings	0·10×0·12
Distance between centres of adjacent lateral branches	0·55 to 0·65

Remarks. This species differs from *Penniretepora* sp. A in having larger zooecial openings on a nearly flat obverse surface, a thicker main stem, striae on the obverse surface, and a very different grouping of zooecial openings between the lateral branches.

Genus *PSEUDOHORNERA* Roemer

1876 *Pseudohornera* Roemer : Explanation of pl. 12.
1890 *Drymotrypa* Ulrich : 399.

Diagnosis. Colonies dichotomously branching. Zooecia in several ranges. Zooecial openings angular at the zoarial surface, becoming oval a short distance below the zoarial surface. Reverse surface longitudinally striated.

Type species. *Retepora diffusa* Hall (1852 : 160, pl. 40*c*, figs. 1*a–f*). " Niagaran (Rochester) of New York."

Pseudohornera? sp. A

(Pl. 6, fig. 8 ; Pl. 7, fig. 6)

Material Three etched specimens, PD.4428, PD.4438, PD.4466.

Description. Fragments may be parts of closely bifurcating branches or broken fenestrules of anastomosing colonies. Colony has apparently smooth reverse surface and an obverse surface with three to four rows of oval zooecial openings ; long axis of zooecial opening is in direction of growth of branch. Zooecia alternate but are not in longitudinal ranges.

Measurements in mm.

	PD.4428	PD.4438
Width of zoarial branch	1	0·8
Diameter of zooecial opening	0·30–0·32 ×0·16–0·17	0·30×0·12
No. of zooecial openings per 2 mm. longitudinally	4	$4\frac{1}{2}$

Remarks. These fragments can only be identified as to genus with any degree of certainty. Among the species assigned to *Pseudohornera*, the Portrane species has little similarity to *P. bifida excedens* Männil (1958) from C_3 to E of the Ordovician of Estonia, but has some general similarities in diameter of zoarial branch and size of zooecial opening to *P. striata* Männil (1958) from C_3 of the Ordovician of Estonia The latter species has seven to eight rows of zooecial openings across a zoarial branch, $5\frac{1}{2}$ to 6 zooecial openings per 2 mm., a striated non-celluliferous reverse surface, and zooecial openings which are generally smaller. *P. dichtoma* (Ulrich) (1890 : 399–400) from the " Trenton ", Montreal, Canada, is similar to the Portrane species in having four ranges of zooecial openings on a zoarial branch, but Ulrich's species has more slender zoarial branches, smaller zooecial openings, and more numerous zooecial openings per 2 mm.

Pseudohornera? sp. B

(Pl. 7, fig. 4 ; ?Pl. 5, figs. 1, 2, 6)

Material. One etched specimen, PD.4436. Questionably assigned to this taxon, PD.4408–09.

DESCRIPTION. The colony has a smooth reverse surface, and a highly curved obverse surface with weathered oblique polygonal zooecial openings. These openings could be oval on an unweathered surface. The bifurcating fragmentary branches may be part of a reticulate colony but they do not permit determination of this character.

MEASUREMENTS of PD.4436 in mm.

Diameter of zoarial branch	0·7
Diameter of zooecial opening	0·28–0·20 ×0·20
No. of zooecial openings per 2 mm. longitudinally	7

REMARKS. This fragment differs from *Pseudohornera?* sp. A primarily in the greater number of zooecial openings per 2 mm. This feature could vary in different parts of a colony, but at present it seems that the difference in the fragments should be noted so that when more material is available later the limits of the different species can be more clearly defined.

Thin sections (PD.4408 and 4409—Pl. 5, figs. 1, 2, 6) of a species which appears to have features suggesting *Pseudohornera* are questionably assigned to this taxon.

Genus ***PTILODICTYA*** Lonsdale

1839 *Ptilodictya* Lonsdale : 676.
1960 *Ptilodictya* Lonsdale ; Ross : 1064.

DIAGNOSIS. Bifoliate colonies with ribbon-shaped or explanate forms of growth ; very distinct median set of ranges with a set of lateral ranges on either side. Mesopores and acanthopores lacking. Zooecial walls with escharoporid wall structure. Hemisepta present. Mesotheca simple and lacking median tubuli.

TYPE SPECIES. *Flustra lanceolata* Goldfuss (1829 : 104, pl. 37, figs. 2*a–d*).

Ptilodictya sp. A

(Pl. 7, fig. 1)

MATERIAL. Etched fragments of zoarial stems, PD.4433, 4461 and 4463? (deeply etched).

DESCRIPTION. Slender zoarial stems display no bifurcations. Almost square zooecial openings occur in the median ranges and rectangular zooecial openings in the lateral ranges.

MEASUREMENTS of PD.4433 in mm.

Zoarial width	2 incomplete
No. of zooecial openings per 2 mm. longitudinally in median ranges	8
No. of zooecial openings per 2 mm. longitudinally in lateral ranges	8

No. of median ranges	6
No. of lateral ranges on either side of median ranges	4
Diameter of zooecial opening	Median range 0·25×0·20 0·21×0·20 Lateral range 0·35×0·17 0·40×0·18

Remarks. *Ptilodictya* sp. A is similar to such delicate species as *P. ensiformis* (Hall) (Ross 1960 : 1067–1069) which ranges from the English Head Formation through the Jupiter Formation (Cincinnatian to Niagaran), Anticosti Island, and *Dicranopora emacerata* (Nicholson) from the "Cincinnati Group, near Cincinnati, Ohio". In comparison with *Ptilodictya* sp. A, *P. ensiformis* has a narrower zoarial stem, fewer ranges on a stem, and smaller, more rectangular zooecial openings.

Ptilodictya sp. B

(Pl. 7, fig. 3 ; ?Pl. 4, figs. 1–7)

Material. Two etched specimens, PD.4435, 4462. Questionably assigned to this genus, PD.4401–05.

Description. Wide zoarial stems with rectangular zooecial openings in both median and lateral ranges.

Measurements of PD.4435 in mm.

Zoarial branch width	6 to 7
No. of median ranges	7 to 8
No. of lateral ranges	4 to 5
No. of zooecial openings per 2 mm. longitudinally in median ranges	5
No. of zooecial openings per 2 mm. longitudinally in lateral ranges	4
Diameter of zooecial opening in median and lateral ranges	0·35×0·20 0·37×0·17

Remarks. This species is represented by a considerably wider zoarial stem than *Ptilodictya* sp. A. It is a typical species of the genus *Ptilodictya*, belonging to the group that includes *P. lanceolata* (Goldfuss) from the Upper Llandovery to Lower Ludlow of Gotland and the Wenlock of England, and *P. canadensis* Billings from the English Head Formation to Jupiter Formation (Cincinnatian to Niagaran), Anticosti Island. In comparison with these two species, *Ptilodictya* sp. B, though 6 to 7 mm. in width, has fewer longitudinal ranges across the branch and longer zooecial openings.

A number of incomplete zoarial fragments which were observed only in thin section (PD.4401–05—Pl. 4, figs. 1–7) are questionably placed in this species because not all features of the colonies are determinable. PD.4402 (Pl. 4, fig. 2) has 5 to 6

zooecial openings per 2 mm. and the zooecial openings measure 0·22 to 0·32 × 0·10 to 0·12 mm. in the median ranges. These measurements suggest that the fragment may be assignable to *Ptilodictya* sp. B which has fewer zooecial openings per 2 mm. than *Ptilodictya* sp. A.

Ptilodictya sp. C

MATERIAL. One etched specimen, PD.4456.

REMARKS. This small fragment, which is part of a wide zoarial branch, appears to have some similarity to *Ptilodictya* sp. B, from which it differs in having thinner zooecial walls, more elongate and narrower zooecial openings, fewer median ranges, and a greater number of lateral ranges.

MEASUREMENTS in mm.

Zoarial branch width	4·2 incomplete
No. of median ranges	4 to 5
No. of lateral ranges	9 to 10
No. of zooecial tubes per 2 mm. longitudinally in median ranges	$5\frac{1}{2}$
No. of zooecial tubes per 2 mm. longitudinally in lateral ranges	4 to $4\frac{1}{2}$
Diameter of zooecial opening in median range	0·32×0·07 0·35×0·10
Diameter of zooecial openings in lateral ranges	0·37×0·10 0·42×0·12

Genus ***PACHYDICTYA*** Ulrich

Pachydictya sp. A

(Pl. 7, fig. 10 ; ?Pl. 5, figs. 8, 9)

MATERIAL. PD.4415–16, 4442. Questionably assigned to this taxon, PD.4413–14.

REMARKS. The slender zoarial stem lacks any kind of lateral margin. This form differs from *Pachydictya* sp. B in having a more delicate colony, narrower zoarial stem, and larger zooecial openings.

MEASUREMENTS of PD.4442 in mm.

Width of zoarial branch	2·6
No. of zooecial openings per 2 mm. longitudinally	4
Diameter of zooecial opening	0·30 to 0·35 ×0·15 to 0·17

Specimen PD.4416 appears to belong to this species because it has a zoarial branch width of 1·32 mm. incomplete ; $5\frac{1}{2}$ zooecial openings per 2 mm. longitudinally ; diameter of zooecial opening 0·18 to 0·21 × 0·10 to 0·13 mm. ; no apparent lateral

margin; and zooecial wall thickness of 0·026 to 0·042 mm. The thick zooecial walls have a distinct peristome around the zooecial openings and wide areas between the zooecial openings. Another specimen, PD.4415, appears also to belong to this species. Its zoarial stem depth is 1·43 mm.; the diameter of the zooecial opening is 0·21 × 0·13, and the thickness of the peristomal wall is 0·026 to 0·042 mm. Two thin sections (PD.4413–14—Pl. 5, figs. 8, 9), although oriented obliquely, appear to have delicate zoarial features comparable to *Pachydictya* sp. A.

Pachydictya sp. B

(Pl. 7, fig. 11)

Material. PD.4443 and 4457.

Remarks. The two fragments of robust zoarial stems have wide non-celluliferous margins, round zooecial openings in longitudinal ranges, and papillose walls suggesting acanthopores that encircle the zooecial openings. Interspaces are not apparent in these etched specimens, but they may be covered by interstitial material.

Measurements of PD.4443 in mm.

Width of zoarial branch	4·5
No. of zooecial openings per 2 mm. longitudinally	5
Diameter of zooecial tubes	0·25 to 0·32 × 0·17 to 0·25
Width of lateral margin	0·5 to 0·6

Genus ***STICTOPORA*** Hall

1847 *Stictopora* Hall : 73.
1849 *Sulcopora* d'Orbigny : 499.
1882 *Rhinidictya* Ulrich : 152.
1890 *Rhinidictya* Ulrich ; Ulrich : 388, 492.
1921 *Hemidictya* Coryell : 303.
1960 *Stictopora* Hall ; Phillips : 7.
1961 *Stictopora* Hall ; Ross : 336.

Diagnosis. Bifoliate branching colonies with zooecial openings in longitudinal ranges. Acanthopores encircling zooecial openings. Mesotheca penetrated by numerous median tubuli. Hemisepta and diaphragms may be present.

Type species. *Stictopora fenestrata* Hall (1847, pl. 4, figs. 4*a–d*).

Remarks. *Stictopora* Hall is used in the present discussion in preference to its junior synonym *Rhinidictya* Ulrich which was extensively used in the past few decades by Ulrich and Bassler. Ulrich (1890 : 492) stated that *Rhinidictya* was *Stictopora* Hall and examination of the type species of both genera substantiates Ulrich's statement.

Stictopora sp.

(Pl. 5, figs. 4, 10 ; Pl. 7, fig. 2 ; ?Pl. 5, fig. 7)

Material. PD.4434, 4410. Questionably assigned to the genus, PD.4412, 4417, 4459.

Remarks. The few fragments of *Stictopora* which are present in the Portrane Limestone can only be identified as to genus. From the few features and measurements that can be determined, this form has wider zoarial branches and fewer zooecial openings per 2 mm. than the type species, *S. fenestrata.*

Measurements of PD.4434 in mm.

Width of zoarial branch	2·7 to 3·0 incomplete
No. of zooecia per 2 mm. longitudinally . .	4 to $4\frac{1}{2}$
Diameter of zooecial openings	0·25 to 0·17 × 0·08 to 0·10
No. of ranges per 2 mm. laterally . . .	11

Several fragments of *Stictopora* are grouped in this discussion and it is not possible to determine from the fragmentary material if they are conspecific. PD.4410 (Pl. 5, figs. 4, 10) has $6\frac{1}{2}$ to 7 zooecial openings per 2 mm., zoarial stem width of 1·76 mm. incomplete, at least 10 ranges across the branch, and zooecial openings 0·16 to 0·18 × 0·08 to 0·10. This fragment has smaller zooecial openings and slightly more numerous zooecial openings per 2 mm. than PD.4434. PD.4412 (Pl. 5, fig. 7) is a very distinctive transverse section with median tubuli and acanthopores in the peripheral region ; zoarial width is 0·77 mm. and zoarial depth is 0·66 mm. An unfigured specimen, PD.4417, longitudinal section, has a narrow peripheral region (0·04 mm.), thin zooecial walls, zoarial depth of about 0·55 mm., and about 5 to 6 zooecial openings per 2 mm.

Genus *ICHTHYORACHIS* M'Coy

1844 *Ichthyorachis* M'Coy : 205.

Type species. *Ichthyorachis newenhami* M'Coy (1844 : 205) by monotypy.

Diagnosis. " Gen. Ch.—Coral plumose, composed of a straight, central stem or midrib, having on each side a row of short, simple branches or pinnae, all in the same plane ; obverse both of the midrib and lateral branches rounded, without keel, and each bearing several rows of small, prominent, oval pores, arranged in quincunx; reverse rounded, smooth, or finely striated." (M'Coy, 1844, p. 205).

Remarks. M'Coy further stated, " The present genus stands nearly in the same relations to *Glauconome*, Lons., as *Polypora*, M'Coy, does to *Fenestella*, Miller. *Fenestella* and *Glauconome* are carinate on the obverse, and bear two rows of large, prominent pores, while *Polypora* and *Ichthyorachis* are rounded on the obverse, and bear several rows of small pores arranged in quincunx. . . ."

Cf. ***Ichthyorachis*** sp.

(Pl. 6, fig. 13)

MATERIAL. PD.4431.

DESCRIPTION. Pinnate zoarium has thick main stem and thinner lateral branches. Both the main and lateral branches appear to have the same number of zooecial ranges on their obverse surfaces; the zooecial openings are aligned in one median longitudinal range, two lateral longitudinal ranges (one on each side of the median range) and two irregular lateral rows which are partly discontinuous owing to junctions of lateral branches with the main stem. The zooecial openings are normal to the zoarial surface in the median and two lateral ranges, but oblique in the irregular lateral ranges. The reverse surface is smooth, that of the main branch slightly keeled.

MEASUREMENTS in mm.

Diameter of main zoarial branch	1·8
Diameter of lateral zoarial stems	0·9 to 1·0
No. of zooecial openings per 2 mm. on main stem	4 to 5
Diameter of zooecial openings	0·30×0·15
	0·32×0·17

REMARKS. This species does not appear to have close similarities to previously described polyzoans. Initially it appears to be similar to *Pteropora*, but Männil (1958) has shown that this genus is bifoliate whereas the Portrane species is bipartite. *Ichthyorachis* M'Coy appears to be the only genus with which the Portrane specimen can be compared. Nevertheless, *Ichthyorachis*, which to date has been found in Devonian to Permian rocks, is still distinctly different from the Portrane specimen. The general similarity between M'Coy's material and the Portrane specimen lies in the pinnate form of both colonies and the number of zooecial openings across the branch. Both forms have five longitudinal ranges of zooecia on the main stem. However, *Ichthyorachis* does not have the distinct longitudinal ridges which separate the five longitudinal ranges of zooecial openings on the Portrane specimen. The two forms may belong to the same evolutionary lineage or may represent independent parallel evolution of features found in both forms. Unfortunately the internal characters of neither form are known. It seems advisable at this time to compare the Portrane species with *Ichthyorachis*. If the Portrane species belongs to this genus it means that the range of the genus extends back to at least the late Ordovician.

Genus ***HELOPORA*** Hall

Helopora? sp.

(Pl. 3, fig. 5; Pl. 6, fig. 4; Pl. 7, fig. 7)

MATERIAL. PD.4418, 4439, 4400.

REMARKS. The zoarium is slender, bifurcating. The zooecial openings are oblique, directed distally, occur round the zoarial branch, and have peristomes apparently with a circlet of fine pin-heads which may be acanthopore-like structures.

The zooecia alternate in adjacent longitudinal rows, but because the zooecial openings abut in an interlocking pattern the ranges are not clearly defined. In specimen PD.4439 the number of zooecia per 2 mm. is $3\frac{1}{2}$; diameter of zoarial branch is 0·8 mm.; and the diameter of the zooecial openings is 0·12 × 0·10. In external appearance the Portrane form has general features which suggest affinities to *Helopora* and the figured specimen is assigned to this genus with doubt. The transverse section of a very slender polyzoan (PD.4418—Pl. 6, fig. 4) looks much like the section that was figured as *Helopora lindstromi* from " Upper Silurian, Gotland " by Ulrich (1890, text-fig. 18*g*). Both are similar in the arrangement of the zooecial walls, which form a radiating spoke-like pattern, and in the considerably thickened zooecial walls in the peripheral region. The Portrane specimens do not appear similar in external appearance to species which were assigned to *Helopora* from Anticosti Island by Bassler (1928).

Genus ***NEMATOPORA*** Ulrich

Nematopora? sp.

(Pl. 7, fig. 8)

Material. PD.4440, 4465.

Remarks. Specimen PD.4440 (Pl. 7, fig. 8) is a very slender colony (0·9 mm. diameter) with very narrow zooecial openings (0·22 to 0·27 × 0·03 to 0·05 mm. extending all around the stem. This etched specimen and PD.4465 appear to be similar to various forms placed in *Nematopora*, e.g., species of *Nematopora* illustrated by Ulrich (1890, pl. 29, text-figs. 7*a*, 10*a*). Because the internal structures of the two Portrane specimens are not known, they are doubtfully assigned to the genus. *Orthopora* Hall has longitudinal rows of slit-like zooecial openings separated by nodose ridges which are not present in the Portrane specimens.

Genus "***PHYLLOPORINA***"

"***Phylloporina***" sp.

Material. PD.4448.

Description. Irregular anastomosing branches with long narrow fenestrules and an occasional transverse dissepiment. Obverse surface has two rows of round zooecial openings on steeply sloping faces which meet in a poorly defined ridge. The ridge may have nodes but it is difficult to determine in this etched specimen. The apparently smooth reverse surface is possibly faintly striate. $7\frac{1}{2}$ to 8 zooecial openings per 2 mm., and zoarial stem width is 0·2 to 0·3 mm.

Remarks. The irregular meshwork with occasional dissepiments and zooecial openings on steeply sloping faces suggests *Reteporina* d'Orbigny (Miller 1962 : 545–546), but this genus lacks the ridge between the lateral sloping faces which is present in the Portrane specimen. Until more of the phylloporinid genera are more precisely defined, the Portrane specimen is assigned to " *Phylloporina* ".

PHYLLOPORINID

(Pl. 5, fig. 7; Pl. 6, fig. 10)

MATERIAL. PD.4412, PD.4430.

DESCRIPTION. Reticulate or fenestrate zoarium with rectangular arrangement of branches. Zooecia are present on branches and cross-bars. Generally three to four ranges of round zooecial openings across the obverse side of a branch. The reverse surface is non-celluliferous and very faintly striate. These striae may be zooecial walls showing through the translucent etched surface.

MEASUREMENTS in mm.

Zoarial branch width	0·5 to 0·6
No. of zooecia per 2 mm.	10
Diameter of zooecial opening	0·15 to 0·18
	×0·12 to 0·15
Length of cross-bar	0·2 to 0·5
Width of cross-bar	0·4 to 0·6

REMARKS. This form has general similarities to such phylloporinids as *Sardesonina*, *Trepostomina*, and *Subretepora*. Unfortunatley this species has only been found in thin sections and all characters are not available for specific or generic determination.

Order CYCLOSTOMATA Busk

Genus ***HEDERELLA*** Hall

***Hederella* (*Hederella*)** sp.

MATERIAL. PD.4453.

DESCRIPTION. The unfigured specimen PD.4453 is a small fragment of a hederelloid with the long zooecial tubes budding in various directions and different planes. Diameter of zooecial tubes is 0·6 mm. and distance between successive buds is 2·3 to 2·5 mm.

Genus ***CLONOPORA*** Hall

***Clonopora*?** sp.

(Pl. 7, fig. 9)

MATERIAL. PD.4441.

DESCRIPTION. Specimen, PD.4441 (Pl. 7, fig. 9) consists of isolated zooecial tubes that open all around the colony. The zooecial openings do not appear to be constricted. It is not possible to determine from the fragment if the zooecial tubes are arranged in a spiral. It most closely resembles *Clonopora*, which has previously been identified only from the Lower Devonian. Diameter of zooecial opening is 0·31 × 0·37 mm. and the length of the zooecial tube before curvature is 1·0 mm.

Family **DIASTOPORIDAE** Gregory

Genus ***DISCOSPARSA*** d'Orbigny

***Discosparsa*? sp.**

(Pl. 8, figs. 1–3, 7)

MATERIAL. Two etched specimens, PD.4468, 4469.

DESCRIPTION. Small cupuliform zoaria with smooth outer wall enclosing cup-like colony. The colony has a broad calyx filled with zooecial tubes closely packed together in regular radial and circular patterns. Direct zooecial tubes in the outer two circlets at the perimeter of the colony are round to oval in outline and smaller than the slightly oblique zooecial tubes that comprise the remainder of the colony. The zooecial tubes are more irregular in outline in the axial region and approach a polygonal outline.

MEASUREMENTS in mm.

	PD.4468	PD.4469
Diameter of calyx . .	10–12 incomplete	8
Height of colony . .	8	5–6
Size of zooecial tube in cross-section . . .	0·5 to 0·7 in axial region, 0·3 at perimeter	0·4 to 0·5 in axial region, 0·3 at perimeter

REMARKS. This puzzling Portrane species belongs to the Diastoporidae. Among the Palaeozoic genera which have so far been described, it appears similar to *Berenicea*, but its closely packed zooecial tubes in regular radial arrangement in a cup-like colony differentiate it from *Berenicea*, which includes unilamellar subcircular sheets of loosely aggregated zooecial tubes. The Portrane form most closely approaches *Discosparsa*, described by d'Orbigny from the Cretaceous of France. It has the same form of colony and the same arrangement of zooecial tubes as such species as *D. laminosa* d'Orbigny and *D. cupola* d'Orbigny (cf. Pl. 8, figs. 1–3, 7 with d'Orbigny, 1850–1851, pl. 757, figs. 12–14; pl. 758, figs. 2, 4). D'Orbigny's species appear to be smaller in zoarial size than the Portrane species.

Polyzoa or ***Algae***

(Pl. 6, fig. 9; Pl. 7, fig. 13)

MATERIAL. PD.4429 and 4445.

REMARKS. These two specimens of doubtful systematic position are also included in the Portrane fauna.

III. ACKNOWLEDGMENTS

I am grateful to Dr. A. D. Wright, Queen's University, Belfast, for lending me this material for examination and for his kind assistance with numerous enquiries about the Portrane fauna; and to Professor N. D. Newell, American Museum of

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PLATE 1

Anaphragma portranense sp. nov. p. 111

FIG. 1. Tangential section showing amalgamate part of zooecial walls penetrated by small acanthopores. P.D. 4390. ×50.

FIG. 2. Portion of longitudinal section showing general aspect of zooecial tubes, mesopores, and crenulate zooecial walls. P.D. 4390. ×50.

FIG. 4. Oblique longitudinal section showing general aspect of zooecial tubes, mesopores, and crenulate zooecial walls. PD. 4390. ×20.

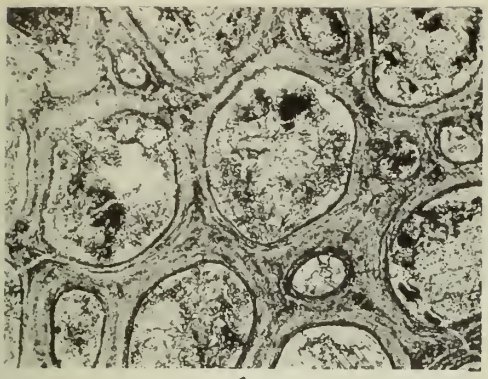
FIG. 6. Portion of oblique longitudinal section showing overgrowth on zoarial stem. PD. 4391. ×20.

Bythopora? sp. p. 118

FIG. 3. Oblique longitudinal section with acanthopores in peripheral region. PD. 4392. ×20.

Amplexopora sp. p. 117

FIG. 5. Oblique longitudinal section showing diaphragms in zooecial tubes and mesopores and acanthopores penetrating zooecial walls. PD. 4393. ×20.



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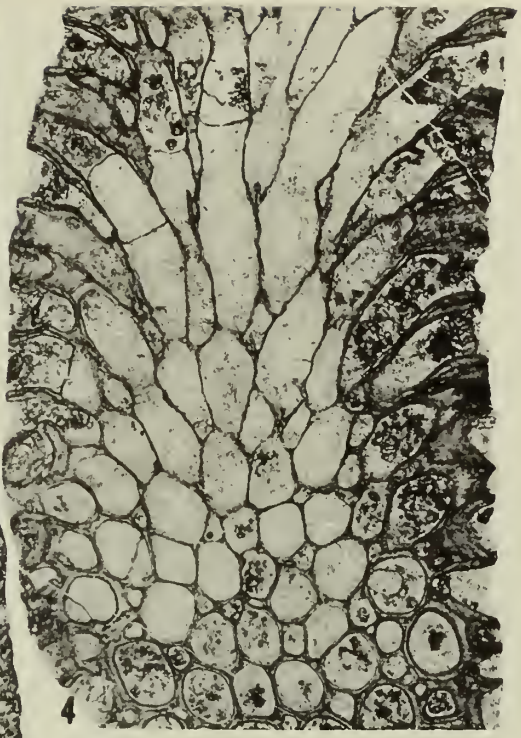

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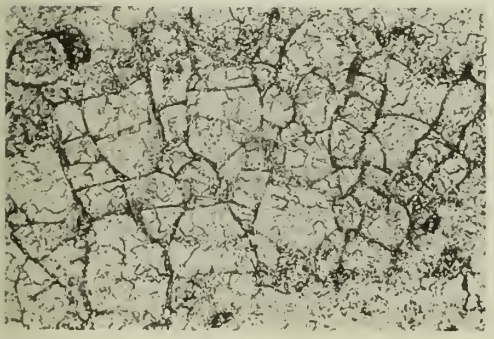

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PLATE 2

***Dianulites*? sp.** p. 115

FIGS. 1, 8. Tangential sections showing circular zooecial openings almost completely enclosed by concentric band of polygonal mesopores. PD. 4385. ×20 and ×50, respectively.

FIGS. 2, 5. Shallow tangential sections showing dense granular walls enclosing subpolygonal mesopores and zooecial openings. PD. 4386. ×50 and ×20, respectively.

FIGS. 3, 4. Part of oblique longitudinal section showing dense granular walls and diaphragms in the mesopores. PD. 4387. ×50 and ×20, respectively.

FIGS. 6, 7. Shallow tangential section showing zooecia and mesopores without distinctive symmetric pattern such as in Figs. 1 and 8. PD. 4388 and PD. 4389, respectively. ×50 and ×20, respectively.

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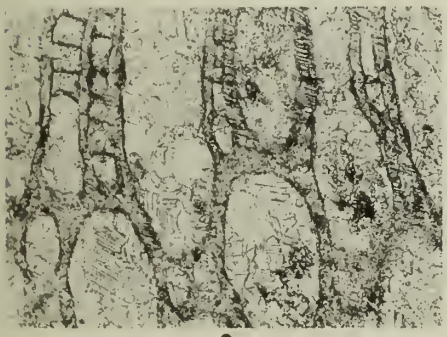

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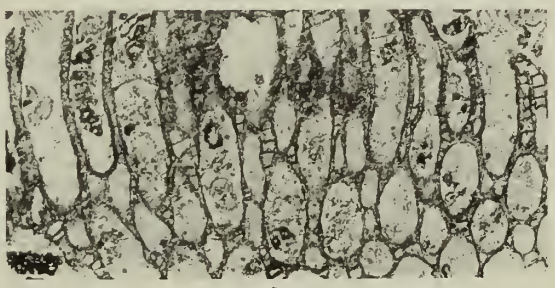

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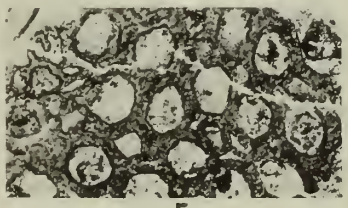

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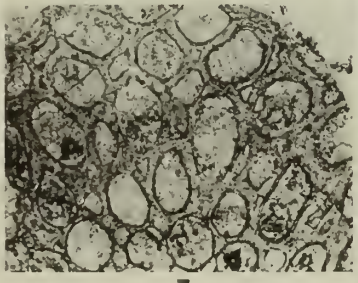

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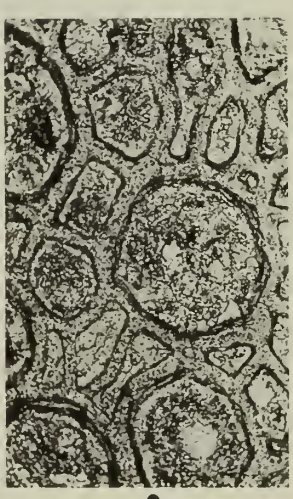

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PLATE 3

Calopora sp. A p. 113

FIG. 1. Tangential section showing well defined concentric bands of inner parts of zooecial walls separated by clear amalgamate outer parts of zooecial walls; narrower inner parts of mesopore walls separated by narrow amalgamate outer part. PD. 4394. ×50.

FIGS. 2, 3. Parts of longitudinal section showing slender zooecial walls, sparse diaphragms in zooecial tubes, and closely spaced diaphragms in mesopores. PD. 4395. ×20 and ×50, respectively.

FIG. 4. Oblique transverse section showing general aspect of zooecial tubes in axial and peripheral regions. PD. 4396. ×20.

FIG. 6. Oblique tangential section showing general arrangement of zooecial openings and diaphragms in zooecial tubes and mesopores. PD. 4394. ×20.

FIG. 8. Part of longitudinal section in peripheral region showing overlapping diaphragms in zooecial tubes and flat diaphragms in mesopores. PD. 4394. ×50.

Helopora? sp. p. 130

FIG. 5. Transverse section showing zooecial walls converging in axial region and subtriangular shape of zooecial tubes. PD. 4400. ×50.

Calopora? sp.

FIG. 7. Longitudinal section in peripheral region showing numerous diaphragms in zooecial tubes. PD. 4399. ×20.


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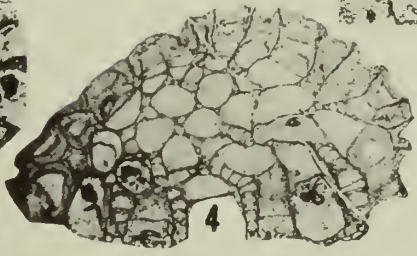
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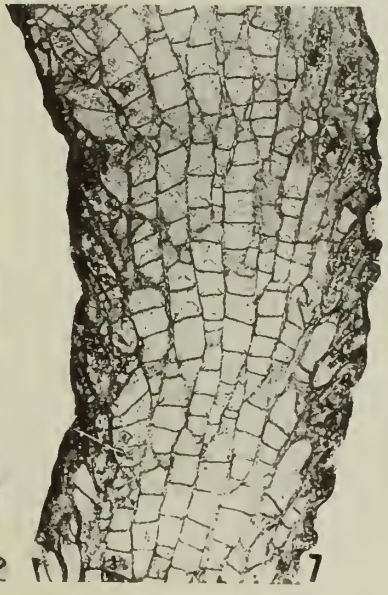
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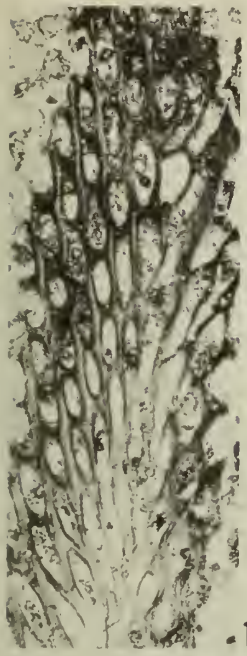
PLATE 4

Ptilodictya sp. B? p. 126

FIGS. 1, 4. Tangential section. PD. 4401. ×20 and ×50, respectively.
FIG. 2. Tangential section. PD. 4402. ×20.
FIG. 3. Longitudinal section. PD. 4403. ×50.
FIGS. 5, 6. Oblique transverse sections. PD. 4404. ×50.
FIG. 7. Oblique longitudinal section. PD. 4405. ×50.

Amplexopora sp. p. 117

FIGS. 8, 9. Tangential sections showing well defined acanthopores penetrating integrate zooecial walls; small and numerous mesopores. PD. 4406 and PD. 4407, respectively, ×50.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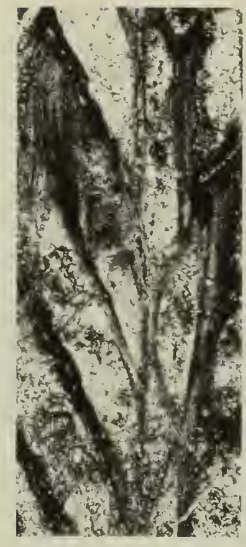
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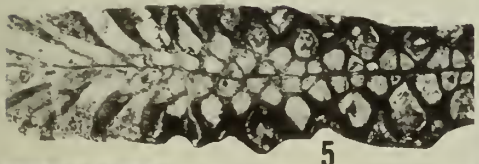
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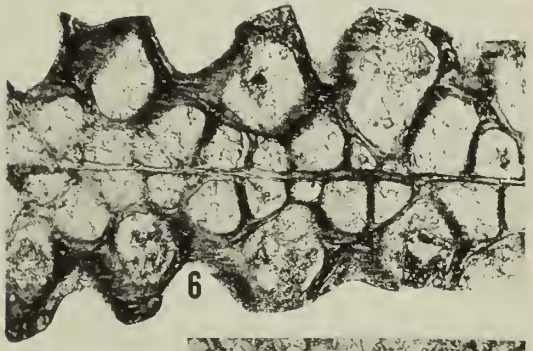
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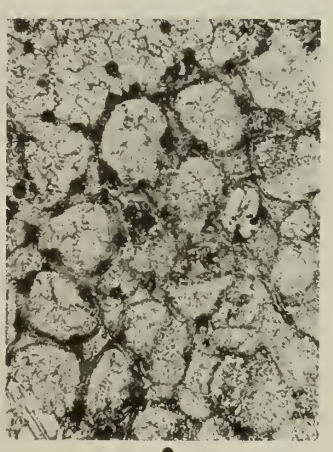
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PLATE 5

***Pseudohornera*? sp.** p. 124

FIGS. 1, 6. Oblique tangential-longitudinal section. PD. 4408. ×50 and ×20, respectively.

FIG. 2. Oblique section of branch enclosing a phylloporinid. PD. 4409. ×20.

***Mitoclemella*? sp. A** p. 120

FIG. 3. Zoarial surface. PD. 4419. ×10.

***Stictopora* sp.** p. 129

FIGS. 4, 10. Oblique tangential section. PD. 4410. ×20 and ×50, respectively.

Phylloporinid p. 132

FIG. 5. Transverse section displaying laminate wall structure. PD. 4411. ×50.

***Stictopora*? sp.** p. 129

FIG. 7. Transverse section. PD. 4412. ×50.

***Pachydictya* sp. A?** p. 127

FIG. 8. Oblique tangential section. PD. 4413. ×50.

***Pachydictya* sp. A?** p. 127

FIG. 9. Longitudinal section. PD. 4414. ×50.


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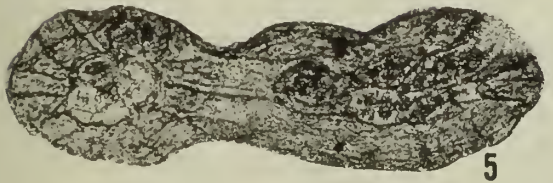
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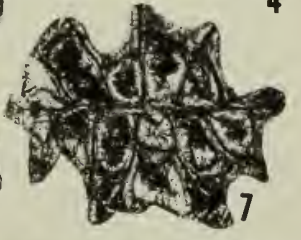
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PLATE 6

All figures ×10, except Fig. 4, ×50.

Calopora sp. A p. 113

FIG. 1. Zoarial surface with zooecial openings and mesopores. PD. 4422.

Calopora sp. B p. 115

FIG. 2. Zoarial surface with zooecial openings and mesopores. PD. 4423.

Penniretepora sp. A p. 122

FIG. 3. Obverse side of main branch and several lateral branches showing zooecial openings. PD. 4424.

Helopora? sp. p. 130

FIG. 4. Transverse section. PD. 4418.

Anaphragma portranense? p. 111

FIG. 5. Zoarial surface. PD. 4425.

Enallopora sp. A p. 119

FIGS. 6, 7. Obverse side of bifurcating colonies showing zooecial openings. PD. 4426 and PD. 4427, respectively.

Pseudohornera? sp. A p. 124

FIG. 8. Obverse side of bifurcating branches with zooecial openings. PD. 4428.

Polyzoan? or ***Alga***? p. 133

FIG. 9. Reticulate colony. PD. 4429.

Phylloporinid p. 132

FIG. 10. Obverse side of reticulate zoarium showing zooecial openings. PD. 4430.

Mitoclemella? sp. A p. 120

FIGS. 11, 12. Oblique zooecial openings on zoarial surface. PD. 4420 and PD. 4421, respectively.

Cf. ***Ichthyorachis*** sp. p. 130

FIG. 13. Obverse side of main branch and several lateral branches with zooecial openings. PD. 4431.

Anaphragma portranense? p. 111

FIG. 14. External view of colony. PD. 4432.

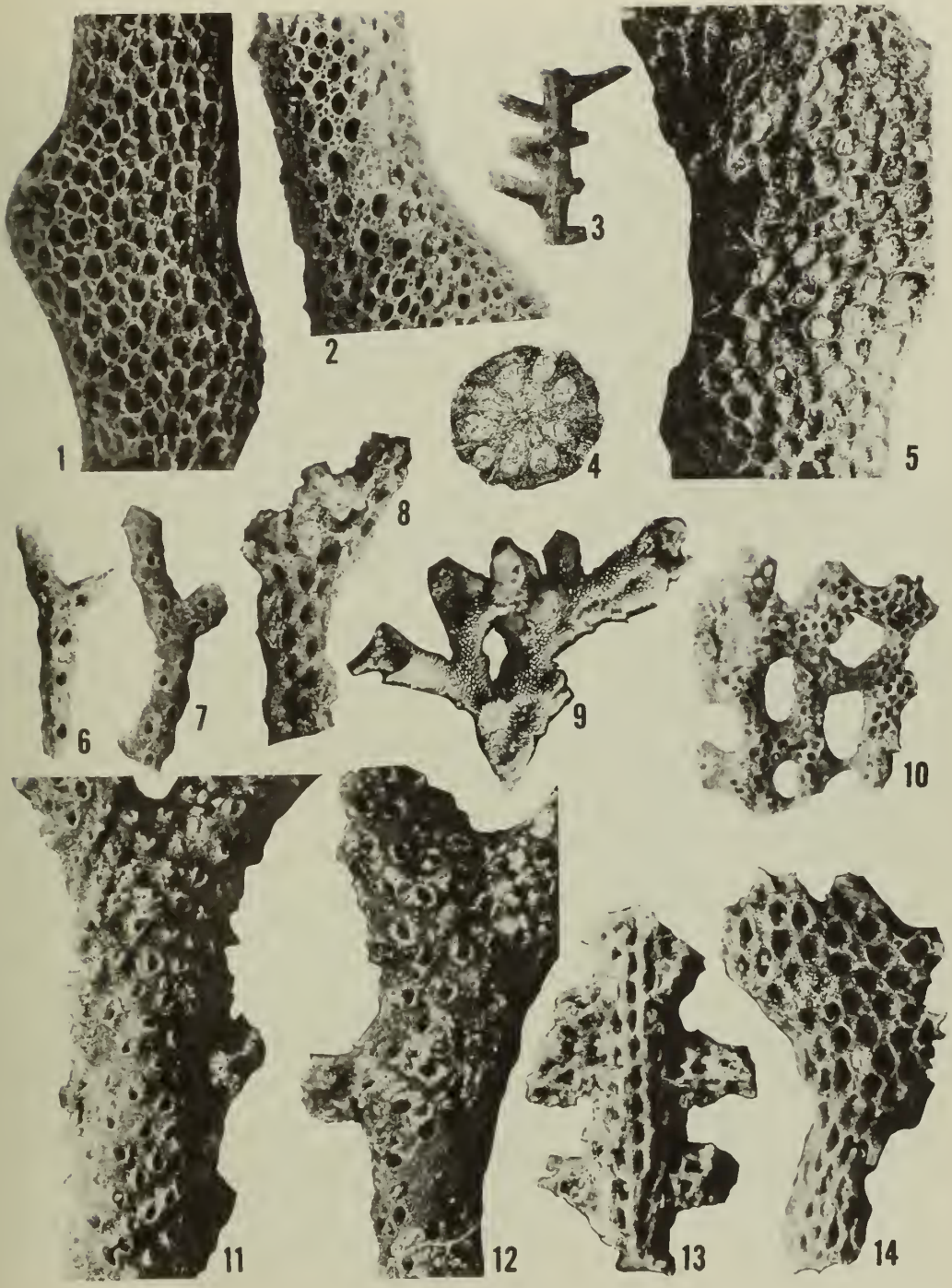
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PLATE 7

All figures ×10

Ptilodictya sp. A p. 125

FIG. 1. Zoarial surface showing direct and oblique zooecial openings. PD. 4433.

Stictopora sp. p. 129

FIG. 2. Zoarial surface with zooecial openings. PD. 4434.

Ptilodictya sp. B p. 126

FIG. 3. Zoarial surface of wide zoarial branch. PD. 4435.

Pseudohornera? sp. B p. 124

FIG. 4. Obverse surface showing zooecial tubes. PD. 4436.

Mitoclemella? sp. A p. 120

FIG. 5. Slender cylindrical stem with oblique zooecial openings. PD. 4437.

Pseudohornera? sp. A p. 124

FIG. 6. Obverse surface with zooecial openings. PD. 4438.

Helopora? sp. p. 130

FIG. 7. Bifurcating colony with oblique zooecial openings. PD. 4439.

Nematopora? sp. p. 131

FIG. 8. Slender cylindrical stem with elongate zooecial openings. PD. 4440.

Clonopora? sp. p. 132

FIG. 9. Isolated diverging zooecial tubes. PD. 4441.

Pachydictya sp. A p. 127

FIG. 10. Part of zoarial surface of branch. PD. 4442.

Pachydictya sp. B p. 128

FIG. 11. Part of zoarial surface of branch. PD. 4443.

Amplexopora? sp. p. 117

FIG. 12. Zoarial surface of fragment of colony. PD. 4444.

Polyzoan? or ***Alga***? p. 133

FIG. 13. Reticulate colony. PD. 4445.

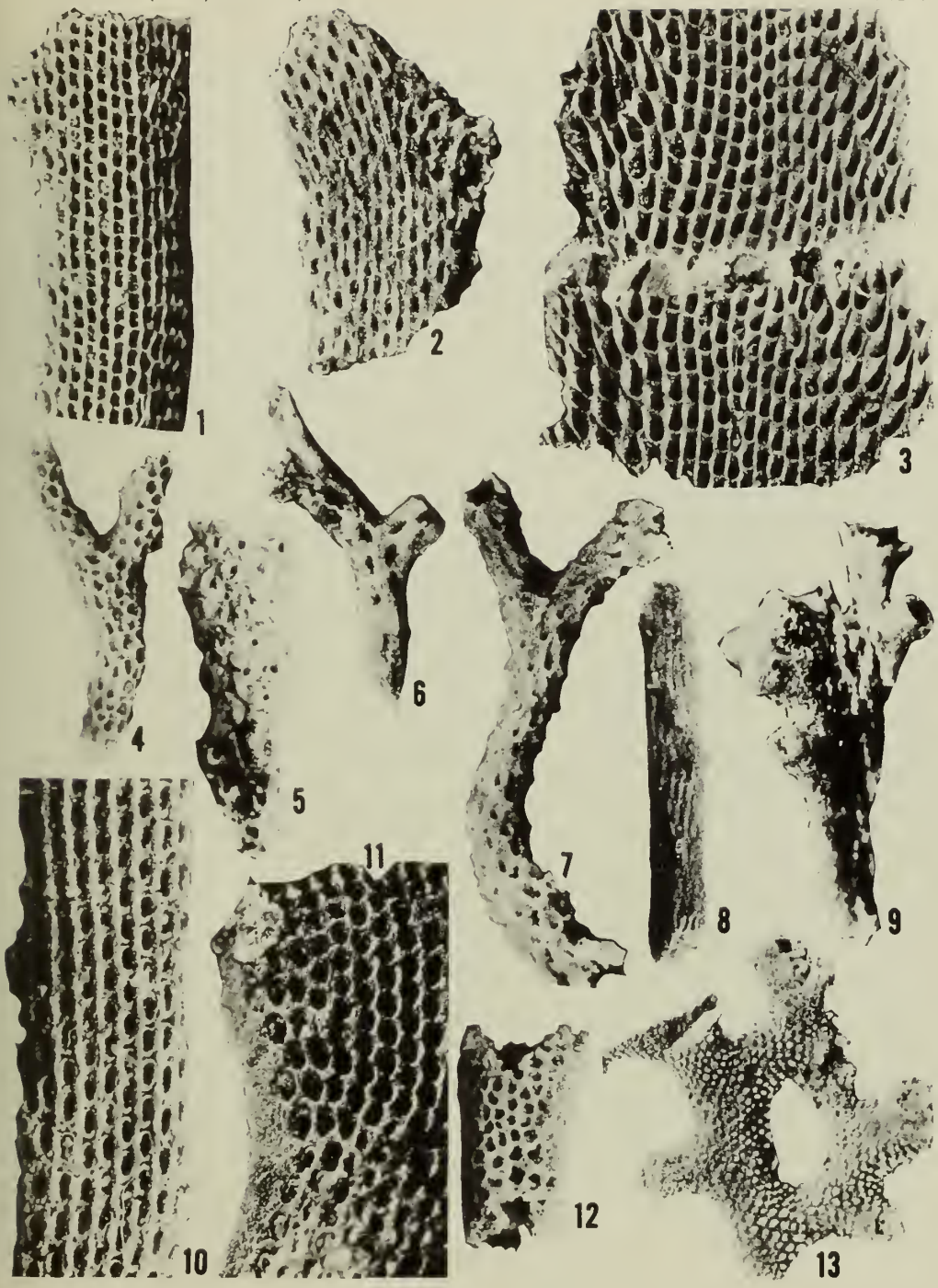
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PLATE 8

***Discosparsa*? sp.** p. 133

FIGS. 1, 2. View of calyx of colony showing zooecial tubes aggregated together in cup-like form. PD. 4468, 4469, respectively. ×5.

FIGS. 3, 7. External aspect of colony showing a small part of external wall of shallow cup-like colony. PD. 4469, 4468, respectively. ×5.

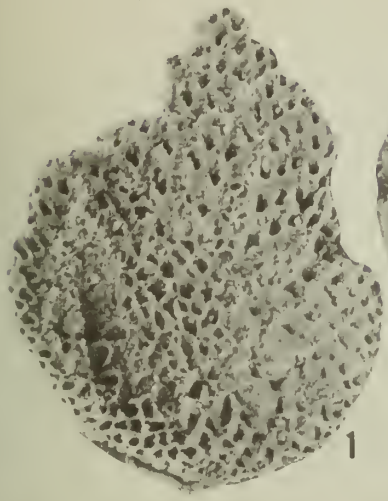
Phragmopora multiporatum Bassler p. 117

FIG. 4. Tangential section showing round zooecial openings and polygonal mesopores. Holotype, USNM 57421. ×50.

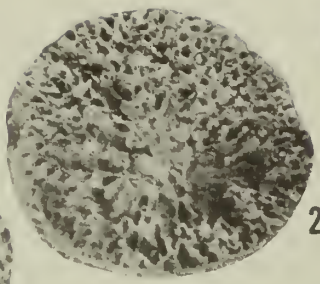
FIG. 6. Longitudinal section of same specimen showing zooecial tubes with hemiphragms and mesopores with diaphragms. ×50.

Penniretepora sp. A p. 112

FIG. 5. Obverse surface of pinnate colony with zooecial openings on steeply sloping surfaces. PD. 4424. ×30.



1



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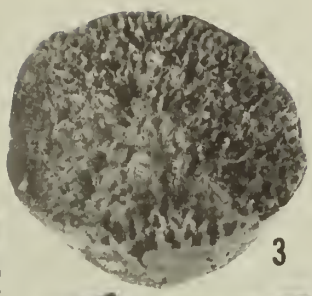

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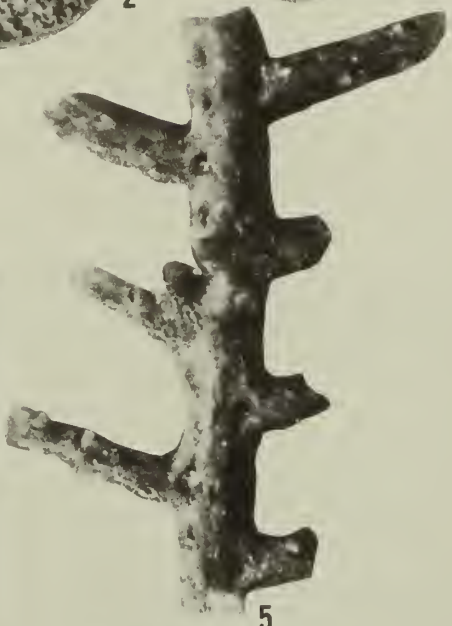

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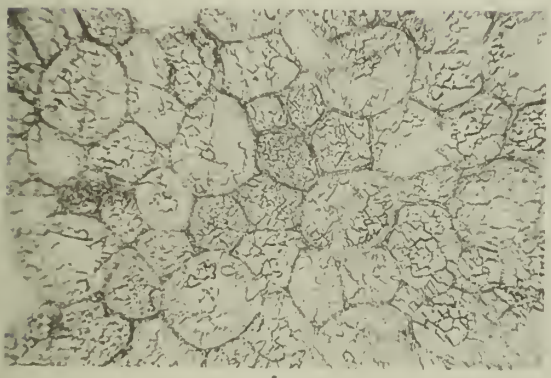

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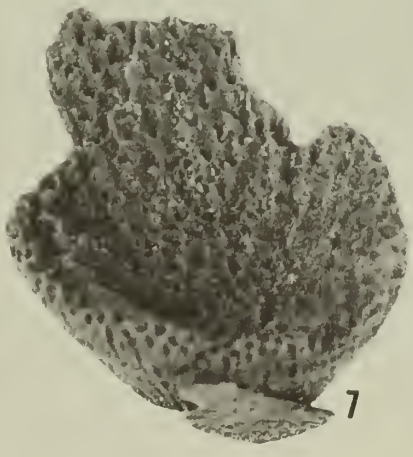

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